IN THE U.S. PATENT AND TRADEMARK OFFICE

Applicants: Mori et al.

Serial No.: 10/542,392

Filed : July 15, 2005

For : PLANT-CULTIVATING DEVICE AND PLANT-CULTIVATING METHOD

Art Unit : 3643

Examiner : Kristen C. Hayes

DECLARATION UNDER 37 C.F.R. 1.132

I, Hiroshi Yoshioka, a Japanese citizen residing at Shimo-Ochiai 11-1, Hadano-shi, Kanagawa-ken, Japan, declare and say:

I took a master course majoring in applied chemistry at the Graduate School of Science and Engineering, Waseda University and I was graduated therefrom in March 1984.

In 1984, I entered Terumo Corporation, Japan.

In 1990, I entered W.R. Grace & Co. (Central Research Laboratories in Japan).

In 1995, I obtained a doctorate in engineering from Waseda University. In that year, I entered Mebiol Inc. Since then, I have been engaged in fundamental studies, research and development of polymer materials used in the medical and agricultural fields.

I am the Executive Vice President of Mebiol Inc.

I am also a visiting associate professor of Advanced Research Institute for Science & Engineering of Waseda University and a

part-time lecturer at St. Marianna University School of Medicine.

I am well familiar with the present case.

I have read and understood the Office Action dated August 21, 2008 and references cited therein.

I have conducted an experiment to cultivate a plant using the system of the present invention as recited in amended claim 1 (submitted on February 20, 2009) of the present application (in which an aqueous fertilizer solution is provided below a non-porous hydrophilic film); and a comparative experiment to cultivate a plant using the system of Tonkin (US Patent no. 6,615,537) and Mori (EP 1 203 525 A1) (in which only water is provided below a non-porous hydrophilic film and a fertilizer is provided in a soil on the film). The materials, methods and results are described in a paper attached hereto and marked "Exhibit 1".

I have also conducted an experiment to cultivate a plant by the method of the present invention as recited in amended claim 7 (submitted on February 20, 2009) of the present application (using a non-porous hydrophilic film), and a comparative experiment to cultivate a plant by the method of Wright (EP 0 268 556 A1) (using a porous hydrophobic film). The materials, methods and results are described in a paper attached hereto and marked "Exhibit 2".

From the results of Exhibits 1 and 2, it can be fairly concluded:

(1) that, when a plant is cultivated using the plant-cultivating system of the present invention which comprises a non-porous hydrophilic film and an aqueous fertilizer solution provided below the non-porous hydrophilic film, the plant roots unexpectedly integrate

with the non-porous hydrophilic film, and the plant having its roots integrated with the non-porous hydrophilic film exhibits surprisingly enhanced growth and improved quality in terms of Brix (%) value even without providing a fertilizer-containing soil on the film (Experiment 1A of Exhibit 1 and Experiment 1B of Exhibit 2);

(2) that, on the other hand, when a plant is cultivated using the plant-cultivating system of Tonkin and Mori which comprises a non-porous hydrophilic film, water provided below the non-porous hydrophilic film, and a fertilizer-containing soil on the film, the plant roots do not integrate with the non-porous hydrophilic film, and the plant exhibits poor growth and low quality (Comparative Experiment 1A of Exhibit 1);

(3) that, in addition, both Tonkin and Mori suggest that, even if a fertilizer is dissolved in the water provided below the non-porous hydrophilic film, the film is impermeable to the fertilizer so that the plant on the film cannot absorb the fertilizer through the film (Exhibit 1);

(4) that, further, by the method of Wright using a plant-cultivating system comprising a porous hydrophobic film, the growth of a plant was very poor (Comparative Experiment 1B of Exhibit 2); and

(5) that, therefore, it can be fairly concluded that the combined use of a non-porous hydrophilic film and an aqueous fertilizer solution provided below the non-porous hydrophilic film is essential for efficiently cultivating a high quality plant by hydroponic cultivation (Conclusions of Exhibit 1 and Exhibit 2).

The undersigned petitioner declares that all statements made herein of his own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Date: March 16, 2009

Hiroshi Yoshioka

Hiroshi Yoshioka

Exhibit 1

Experiment to cultivate a plant using the system of the present invention (in which an aqueous fertilizer solution is provided below a non-porous hydrophilic film); and comparative experiment to cultivate a plant using the system of each of Tonkin (US Patent no. 6,615,537) and Mori (EP 1 203 525 A1) (in which only water is provided below a non-porous hydrophilic film and a fertilizer is provided in a soil on the film)

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1. Object of Experiments

In the Office Action dated August 21, 2008, the Examiner rejects claim 1 (formerly directed to "plant-cultivating device" which has been changed to "plant-cultivating system" by the amendment filed on February 20, 2009) of the present application under 35 U.S.C. 102 as being anticipated by each of Tonkin (US Patent no. 6,615,537) and Mori (EP 1 203 525 A1).

In response to the Examiner's rejection, the claims of the present application were amended on February 20, 2009. As can be seen from amended claim 1 currently on file, the characteristic feature of the system of the present invention resides in that an aqueous fertilizer solution is provided below a non-porous hydrophilic film in a manner such that the lower surface of the film is in contact with the surface of the aqueous fertilizer solution. In cultivation of a plant using the system of the present invention, a plant is cultivated by allowing an aqueous fertilizer solution to be contacted with the plant through the non-porous hydrophilic film while allow-

ing roots of the plant to grow on and get integrated with the non-porous hydrophilic film. The system of the present invention enables efficient growth of a high quality plant.

On the other hand, in each of Tonkin (US Patent no. 6,615,537) and Mori (EP 1 203 525 A1), only water is provided below a non-porous hydrophilic film, and a fertilizer is provided in a soil disposed on the film. This is because it has conventionally been believed that, even if a fertilizer is dissolved in the water provided below the non-porous hydrophilic film, the film is impermeable to the fertilizer so that the plant on the film cannot absorb the fertilizer through the film. This is apparent from the following descriptions of Tonkin and Mori:

> "Numerous materials that allow the passage of water whilst restricting the passage of suspended or even dissolved materials are known. One recently identified group of materials are hydrophilic polymers." (emphasis added)(col.1, lines 59 to 62 of Tonkin)
>
> "Suitable hydrophilic non-porous membranes for use in the present invention are non-porous hydrophilic membranes that absorb water and allow water to pass through only by pervaporation." (emphasis added)(col.4, lines 8 to 11 of Tonkin);
>
> "the selective moisture vapor-permeable portion not allowing water to pass therethrough, but allowing water vapor to pass therethrough" (emphasis added)(claim 1 or Mori);
>
> "The moisture vapor-permeability of a film or membrane of a hydrophilic polymer such as the above-mentioned polyvinyl alcohol and various kinds of

> celluloses can be exhibited on the basis of penetration-vaporization phenomenon of water." (emphasis added)(paragraph [0042] of Mori); and
>
> "the moisture vapor which is necessary for cultivation according to the present invention is supplied as water vapor passing through the selective moisture vapor-permeable portion, and therefore the quality of the water per se as a source for supplying water vapor is not particularly limited. In other words, it is possible to use any kind of water (such as seawater, hard water, soft water, and polluted water) for the cultivation method according to the present invention, regardless of the quality thereof." (emphasis added)(paragraph [0074] of Mori)

Needless to say, the above-quoted descriptions mean that only water vapor (gaseous water) can pass through the non-porous hydrophilic film, whereas fertilizer components dissolved in water cannot pass through the film.

In fact, neither Tonkin nor Mori teaches or suggests the addition of a fertilizer to the water provided below the film, and in all of the working examples of Tonkin and Mori, only water is provided below the film and a fertilizer is provided in a soil disposed on the film.

When cultivation of a plant is performed using the system as disclosed in Tonkin and Mori, the integration of plant roots with the film would not occur, and the growth of a plant is very poor as compared to the cultivation using the system of the present invention.

In order to substantiate this, experiments are conducted as follows.

2. Method and Materials

Experiment 1A (present invention)

Preparation of Plant-cultivating System

A plant-cultivating system was prepared in a greenhouse as follows. A polypropylene container (inner width: 34 cm, inner length: 54 cm, depth: 10 cm) was installed on the ground and filled with 10 L of an aqueous fertilizer solution (electric conductivity (EC) = 2.5 as measured by the method described at page 16, lines 22 to 34 of the present specification) containing 15 g of Otsuka House No. 1, 10 g of Otsuka House No. 2 and 0.5 g of Otsuka House No. 5 (each manufactured and sold by Otsuka Chemical Co., Ltd.) A polyvinyl alcohol film (PVA film #6500 (thickness: 65 μm) manufactured and sold by The Nippon Synthetic Chemical Industry Co., Ltd.) having a size of 60 cm × 80 cm was used as a non-porous hydrophilic film.

With respect to the above-mentioned polyvinyl alcohol film, the EC difference (defined in claim 2 of the present application) was 0.0 dS/m, the Brix concentration (%) difference (defined in claim 3 of the present application) was 0.8 %, and the water impermeability (defined in claim 5 of the present application) was 200cm H_2O or more.

The non-porous hydrophilic film was placed on the aqueous fertilizer solution in the container in a manner such that the lower surface of the non-porous hydrophilic film contacts the surface of the aqueous fertilizer solution. Pe-

ripheral portions of the film which extend out of the container were folded downward along the outer surface of the container and fixed thereto. A polyester nonwoven fabric (33 cm × 53 cm; fabric mass density: 25 g/m^2) was placed on the non-porous hydrophilic film, and a hard Styrofoam board (width: 33 cm, length: 53 cm, thickness: 0.7 cm) was placed on the nonwoven fabric as a planting panel. The planting panel had six round holes (diameter: 1.5 cm) arranged at regular 15 cm intervals for planting plants therethrough. The planting panel was covered with a mulching film (polypropylene film manufactured and sold by Ohkura Koyo Co., Ltd.) for preventing the evaporation of the aqueous fertilizer solution in the container. Six X-shaped through-cuts were made on the mulching film at the respective portions thereof which are just above the holes of the planting panel, thereby obtaining a plant-cultivating system of the present invention.

Cultivation of plants

The plant-cultivating system prepared above was used to cultivate Japanese mustard spinach seedlings in the following manner.

Total of six Japanese mustard spinach seedlings (average weight of each seedling: 3 g) were planted through the holes of the plant panel, respectively, so that the roots of the seedlings contacted the upper surface of the non-porous hydrophilic film and that the leaves were placed above the plant panel. Five white fluorescent lamps were installed above the

plant-cultivating system at a position which is 40 cm above the plants, so that the intensity of light to which the plants were exposed became approximately 6,000 Lux. The lamps were used to cultivate the plants under white light regime consisting of 16 hours light and 8 hours dark. The temperature inside the greenhouse was maintained at 20 °C. Cultivation period was 5 weeks (35 days) from the planting of the seedlings.

Evaluation of cultivated plants

(a) Average weight

The cultivated Japanese mustard spinach plants (namely the leaves and the stems of the plants) were harvested on day 35 from the start of the cultivation. Then, the weights of the harvested six plants were measured, and the average weight of the six plants was calculated.

(b) Brix concentration

The Brix concentration (i.e., sugar content) of the leaves was measured as a yardstick for the quality of the plants. The Brix concentration was measured using a Brix meter (Handy refractometer ATC-1E, manufactured and sold by Atago Co., Ltd) by the method described at page 43, line 33 to page 44, line 1 of the present specification. Specifically, several leaves were ground and squeezed to obtain a leaf extract, and a drop of the leaf extract was dropped on the prism portion of the Brix meter. The Brix value of the leaves was obtained by reading the value displayed on the LCD panel of

the Brix meter.

(c) Integration strength

A strength of integration of the roots of the plant with the film (i.e., integration strength) was measured by the method described at page 18, lines 16 to 33 of the present specification. Specifically, after harvesting the plants, from the film having the roots adhered thereto were cut out test specimens each having a width of 5 cm (and a length of about 20 cm) wherein the stem of the plant was positioned around the center of each test specimen. A commercially available clip was attached to a hook hanging from the spring of the spring type balance, and one end of the test specimen obtained above was gripped by the clip, followed by recording the weight ("A" grams) (corresponding to the tare weight of the test specimen) indicated by the spring type balance. Subsequently, the stem of the plant at the center of the test specimen was held by hand and gently pulled downward to detach (or break away) the roots from the film, while recording the weight ("B" grams) (corresponding to the applied load) indicated by the spring type balance. The tare weight was subtracted from this value (that is, "B" grams minus "A" grams) to thereby obtain an integration strength for a width of 5 cm.

Comparative Experiment 1A (Tonkin and Mori)

A plant-cultivating system was prepared in substantially the same manner as in Experiment 1A above except that dis-

tilled water was used instead of the aqueous fertilizer solution, and that about 3,700 ml of a fertilizer-containing culture soil ("Super Mix A" manufactured and sold by Sakata Seed Co., which is the same as used in Example 4 of Mori in which a PVA film was used (paragraph [0098] of Mori)) was disposed on the non-porous hydrophilic film to a thickness of 2 cm instead of the nonwoven fabric.

Using the prepared plant-cultivating system, cultivation of seedlings of Japanese mustard spinach was performed in the same manner as in Experiment 1A and the result of the cultivation was evaluated in the same manner as in Experiment 1A.

2. Results

Results of the evaluation are summarized in the following Table A.

Table A

Evaluation of cultivated plants (Japanese mustard spinach)

	Experiment 2	Comparative Experiment 2
Integration strength	150 g	less than 10 g
Average weight of 6 plants	35.5 g	18.3 g
Brix (%) value of the leaves	5.3 %	3.4 %

As apparent from Table A above, the Japanese mustard spinach plants cultivated in Experiment 1A exhibited an inte-

gration strength as high as 150 g, which indicates that the roots of the plants were firmly integrated with the film. Further, the plants cultivated in Experiment 1A had an average weight as high as 35.5 g and the Brix (%) value as high as 5.3 %. The reason for such excellent results is considered that the plant having its roots integrated with the non-porous hydrophilic film absorbed, through the non-porous hydrophilic film, both water and fertilizers from the aqueous fertilizer solution (provided below the film) in minimum amounts necessary for plant growth.

On the other hand, in Comparative Experiment 1A, substantially no integration of the roots of the plant with the film was observed and, therefore, the integration strength was less than 10 g. Although water was fed to the plant through the film and the fertilizers were fed from the soil disposed on the film, the growth of the plants was poor in Comparative Experiment 1A. Specifically, the average weight of the plants cultivated in Comparative Experiment 1A was only 15.2 g which is about half the weight of plants obtained in Experiment 1A, and the Brix (%) value was only 3.4 %. The reason for this is considered that the plant could not absorb appropriate amounts of water (provided below the film) and the fertilizer (contained in the soil on the film).

3. Conclusion:

From the item "2. Results" above, it is apparent that, when a plant is cultivated using the plant-cultivating system

of the present invention which comprises a non-porous hydrophilic film and an aqueous fertilizer solution provided below the non-porous hydrophilic film (Experiment 1A), the plant roots unexpectedly integrate with the non-porous hydrophilic film. The plant having its roots integrated with the non-porous hydrophilic film exhibits surprisingly enhanced growth and improved quality in terms of Brix (%) value even without providing a fertilizer-containing soil on the film.

On the other hand, when a plant is cultivated using the plant-cultivating system of each of Tonkin and Mori which comprises a non-porous hydrophilic film, water provided below the non-porous hydrophilic film, and a fertilizer-containing soil on the film (Comparative Experiment 1A), the plant roots do not integrate with the non-porous hydrophilic film, and the plant exhibits poor growth and low quality.

Therefore, it can be fairly concluded that the aqueous fertilizer solution provided below the non-porous hydrophilic film is essential for efficiently cultivating a high quality plant by hydroponic cultivation.

Exhibit 2

Experiment to cultivate a plant by the method of the present invention (using a non-porous hydrophilic film), and comparative experiment to cultivate a plant by the method of Wright (EP 0 268 556 A1) (using a porous hydrophobic film)

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1. Object of Experiments

In the Office Action dated August 21, 2008, the Examiner rejects claim 7 (directed to "plant-cultivating method") of the present application under 35 U.S.C. 102 as being anticipated by Wright (EP 0 268 556 A1).

In response to the Examiner's rejection, claim 7 of the present application was amended on February 20, 2009. In amended claim 7 currently on file, the film used for cultivating a plant thereon has been limited to "non-porous hydrophilic film". As can be seen from claim 7, the characteristic feature of the method of the present invention resides in that a plant is cultivated by allowing an aqueous fertilizer solution to be contacted with the plant through the non-porous hydrophilic film while allowing roots of the plant to grow on and get integrated with the non-porous hydrophilic film. Due to such a feature, the method of the present invention enables efficient growth of a high quality plant.

On the other hand, Wright describes the use of a porous film (col.6, lines 18 to 27). In all of the Examples (Examples 1 and 2) of Wright, a microporous polypropylene film

(i.e., a **porous hydrophobic** film) is used (col.12, lines 19 to 21, and col. 13, lines 1 to 4). By the use of such a porous hydrophobic film in cultivation of a plant, growth of a plant is very poor as compared to the cultivation by the method of the present invention which uses a non-porous hydrophilic film.

In order to substantiate this argument, experiments were performed as follows.

2. Method and Materials

In each of the following Experiment 1B (Present invention) and Comparative Experiment 1B (Wright), a plant cultivation was performed using a system where a culture soil containing no fertilizer was provided on a film (i.e., a non-porous hydrophilic film in Experiment 1B and a porous hydrophobic film in Comparative Experiment 1B) in accordance with the working examples of Wright.

Experiment 1B (Present invention)

Preparation of Plant-cultivating System

A plant-cultivating system was prepared as follows. A Styrofoam box (inner length: 50 cm, inner width: 30 cm, depth: 10 cm) was installed on the ground and filled with 2 L of an aqueous fertilizer solution (electric conductivity (EC) = 1.37 as measured by the method described at page 16, lines 22 to 34 of the present specification) containing Matsuzaki No. 1 (0.75g/L) and Matsuzaki No. 2 (0.5 g/L) (each manufac-

tured and sold by Matsuzaki Agribusiness Co., Ltd.) A polyvinyl alcohol film (thickness: 40 μm, manufactured and sold by Aicello Chemical Co., Ltd.) having a size of 40 cm × 48 cm was used as a non-porous hydrophilic film.

With respect to the above-mentioned polyvinyl alcohol film, the EC difference (defined in claim 2 of the present application) was 0.1 dS/m, the Brix concentration (%) difference (defined in claim 3 of the present application) was 0.7 %, and the water impermeability (defined in claim 5 of the present application) was 200 cm H_2O or more.

The non-porous hydrophilic film was placed on the aqueous fertilizer solution in the Styrofoam box in a manner such that the lower surface of the non-porous hydrophilic film contacts the surface of the aqueous fertilizer solution. Vermiculite (which is a cultivation support manufactured and sold by Showa Vermiculite Co., Ltd.) was disposed on the non-porous hydrophilic film in an amount of 0.2 to 0.3 g/cm^2 and, then, the disposed vermiculite was moistened with water so that the moisture content of the vermiculite becomes about 70 %. The vermiculite was covered with an aluminum foil (manufactured and sold by Alfamic Co., Ltd.) used as a mulching film. On the aluminum foil was made four X-shaped through-cuts for planting seedlings therethrough, thereby obtaining a plant-cultivating system of the present invention which is characterized by the use of a non-porous hydrophilic film.

Cultivation of Plants

Using the prepared plant-cultivating system, cultivation of seedlings of arugula (Binomial name: *Eruca sativa* (also known as "rocket")) was performed in the following manner.

Total of four arugula seedlings were planted through the X-shaped through-cuts of the mulching film, respectively, so that the roots of the seedling contacted the upper surface of the film and that the leaves were placed above the mulching film. The planted seedlings were cultivated in a greenhouse using natural sunlight and without any temperature control. During the cultivation, the aqueous fertilizer solution was used in an amount of 2 L in total to compensate for the loss of the aqueous fertilizer solution in the Styrofoam box. Cultivation period was 26 days from the planting of the seedlings.

Evaluation of cultivated plants

The cultivated arugula plants (namely the leaves and the stems of the plants) were harvested on day 26 from the start of the cultivation. The weights of the harvested plants were measured to evaluate the growth of the plants, and the average weight of four plants was calculated.

Comparative Experiment 1B (Wright)

With respect to the film used in Wright for cultivating a plant thereon, Wright states that the film needs to be porous as apparent from the following description:

> "Permeability of the membrane to the aqueous medium is critical, however, and may be caused by "macro-pores" or "micro-pores" (involving or not the molecular structure) provided that the largest openings or pores are small enough to prevent penetration by even the finest plant rootlets and flooding of the plant-exposed side of the interface means under normal conditions. Thus, the pores should in general not exceed about 1 micrometer in diameter and are preferably smaller than 0.1 μm." (emphasis added) (col.6, lines 18 to 27)

That is, Wright teaches that the film (or "membrane") needs to have pores through which aqueous medium can be transmitted, but the pores "should in general not exceed about 1 micrometer in diameter and are preferably smaller than 0.1 μm". With respect to the lower limit of the pore size, Wright has no description. Therefore, in Comparative Experiment 1B, as a replication of the method of Wright, cultivation of plants was performed using the same porous hydrophobic film as used in the Examples of Wright, namely a microporous polypropylene membrane having a pore size of 0.02 μm and a thickness of 130 μm (col.12, lines 19 to 21, and col. 13, lines 1 to 4). More specific explanations are made below.

A plant-cultivating system was prepared in substantially the same manner as in Experiment 1B above except that a microporous polypropylene film having an average pore size of 0.02 μm and a thickness of 130 μm was used instead of the non-porous hydrophilic film.

With respect to the above-mentioned polypropylene film, the EC difference (defined in claim 2 of the present applica-

tion) was 8.8 dS/m (which means that no salt passed through the film as apparent from Table 7 on page 58 of the present specificaiton), and the Brix concentration (%) difference (defined in claim 3 of the present application) was 4.8 %.

Using the prepared plant-cultivating system, cultivation of seedlings of arugula was performed in the same manner as in Experiment 1B and the result of the cultivation was evaluated in the same manner as in Experiment 1B.

3. Results

Results of the evaluation are summarized in the following Table B.

Table B

Evaluation of cultivated plants (arugula)

	Experiment 1B	Comparative Experiment 1B
Average weight of 4 plants	13.5 g	less than 1 g

As apparent from Table B above, the arugula plants cultivated in Experiment 1B grew very well, and the average weight was 13.5 g.

On the other hand, in Comparative Experiment 1B, growth of plants was very poor. Specifically, the average weight of the four arugula plants after 26 days of cultivation was less than 1 g.

The growth of the plant in Comparative Experiment 1B was

so poor that other evaluations (i.e., evaluations of the integration strength and the Brix concentration (i.e., sugar content) were omitted in each of Experiment 1B and Comparative Experiment 1B. However, since the plant could be easily detached from the microporous polypropylene membrane, it was apparent that the integration strength was less than 10 g (which is the lower limit recited in amended claim 6 (filed on February 20, 2009).

The reason for the above results is considered as follows. With respect to Experiment 1B (present invention), it is considered that excellent growth of plants was achieved since the plants absorbed, through the non-porous hydrophilic film, both water and a fertilizer from the aqueous fertilizer solution in minimum amounts necessary for plant growth due to the specific EC difference and Brix concentration (%) difference.

On the other hand, with respect to Comparative Experiment 1B (Wright), from the fact that the plants did not wither even 26 days after the planting of the seedlings and the fact that the EC difference was 8.8 dS/m, it is apparent that the above-mentioned polypropylene film could pass threrethrough water <u>only in the form of water vapor</u>, so that the fertilizer dissolved in the water could not pass the film. This is in agreement with the following teachings of Tonkin and Mori:

> "<u>Hydrophobic porous</u> membranes will also selectively allow the passage of water whilst retaining <u>dissolved or suspended matter</u>." (emphasis added) (col.2, lines 8 to 10); and

"In the thus-prepared fine pore-imparted film or membrane, fine pores are formed through which liquid water cannot pass due to the water repellency of the polymer material, and only water vapor can pass through the film or membrane." (emphasis added)(paragraph [0041] of Mori)

4. Conclusion:

From the item "3. Results" above, it is apparent that the method of the present invention using a plant-cultivating system comprising a non-porous hydrophilic film (Experiment 1B) enables excellent growth of a plant.

On the other hand, by the method of Wright using a plant-cultivating system comprising a porous hydrophobic film, the growth of a plant was very poor (Comparative Experiment 1B).

Therefore, it can be fairly concluded that the use of a non-porous hydrophilic film is essential for cultivating a plant by hydroponic cultivation using an aqueous fertilizer solution.